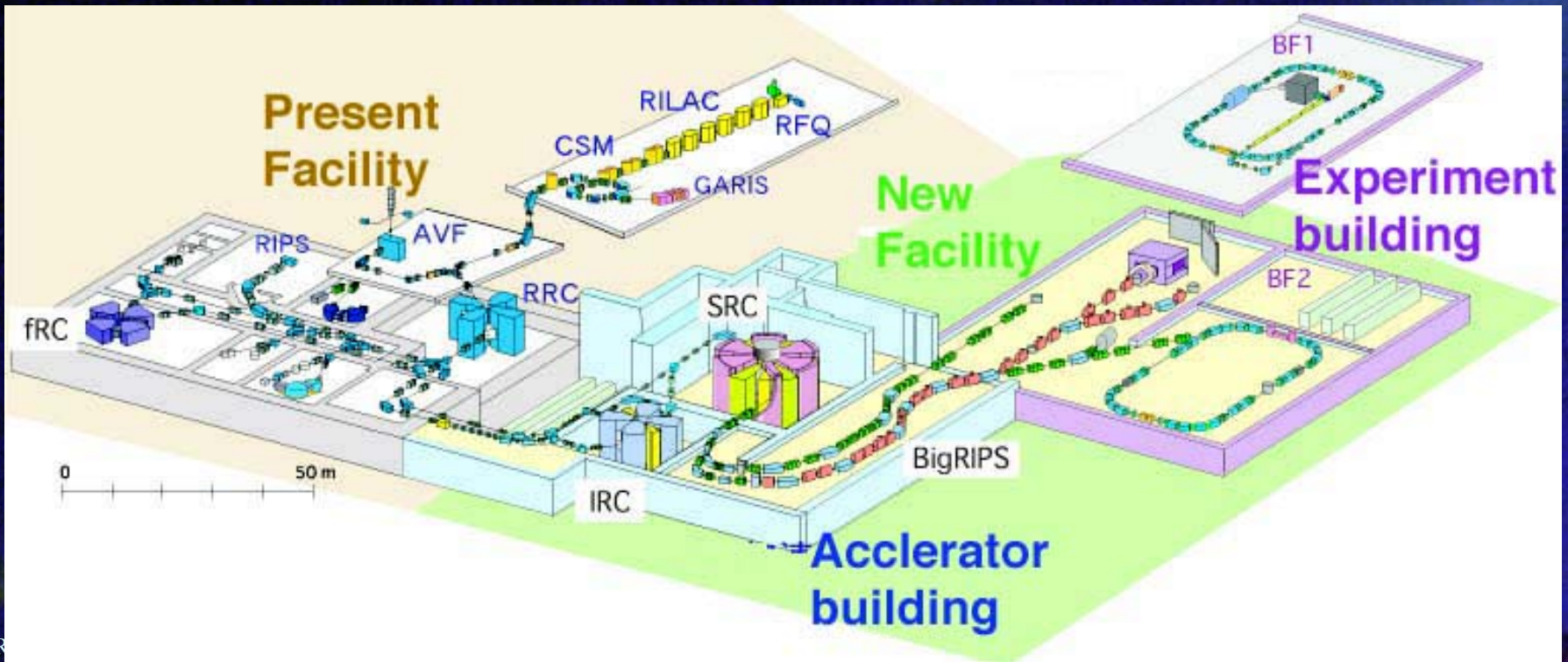


RIKEN RI Beam Factory Plan and R&D Activities

- ◆ The Facility Plan
- ◆ Physics Goals
- ◆ Present status
- ◆ R&D
 - *Production target*
 - *Reaction targets*
 - *Particle ID*
 - *Spectrometers*
 - *Stopped RIB*
 - *Storage ring*
 - *Electron scattering*

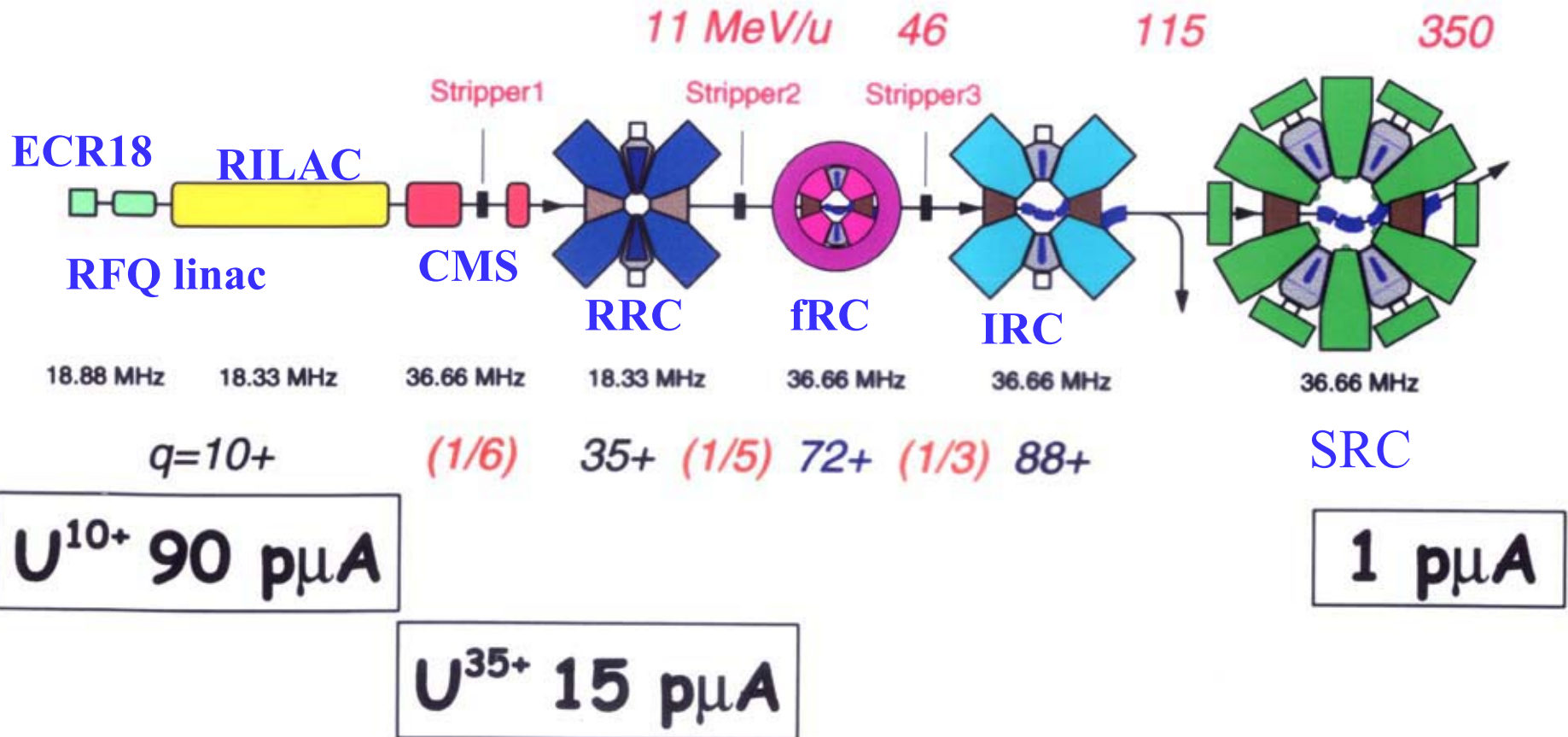
RIKEN-RIBF

- ◆ 400A MeV for light ions with 1 pμA
- ◆ 350A MeV up to U with 1 pμA
- ◆ Accelerators, one separator (Big-RIPS), and a beam line will be ready in 2006.

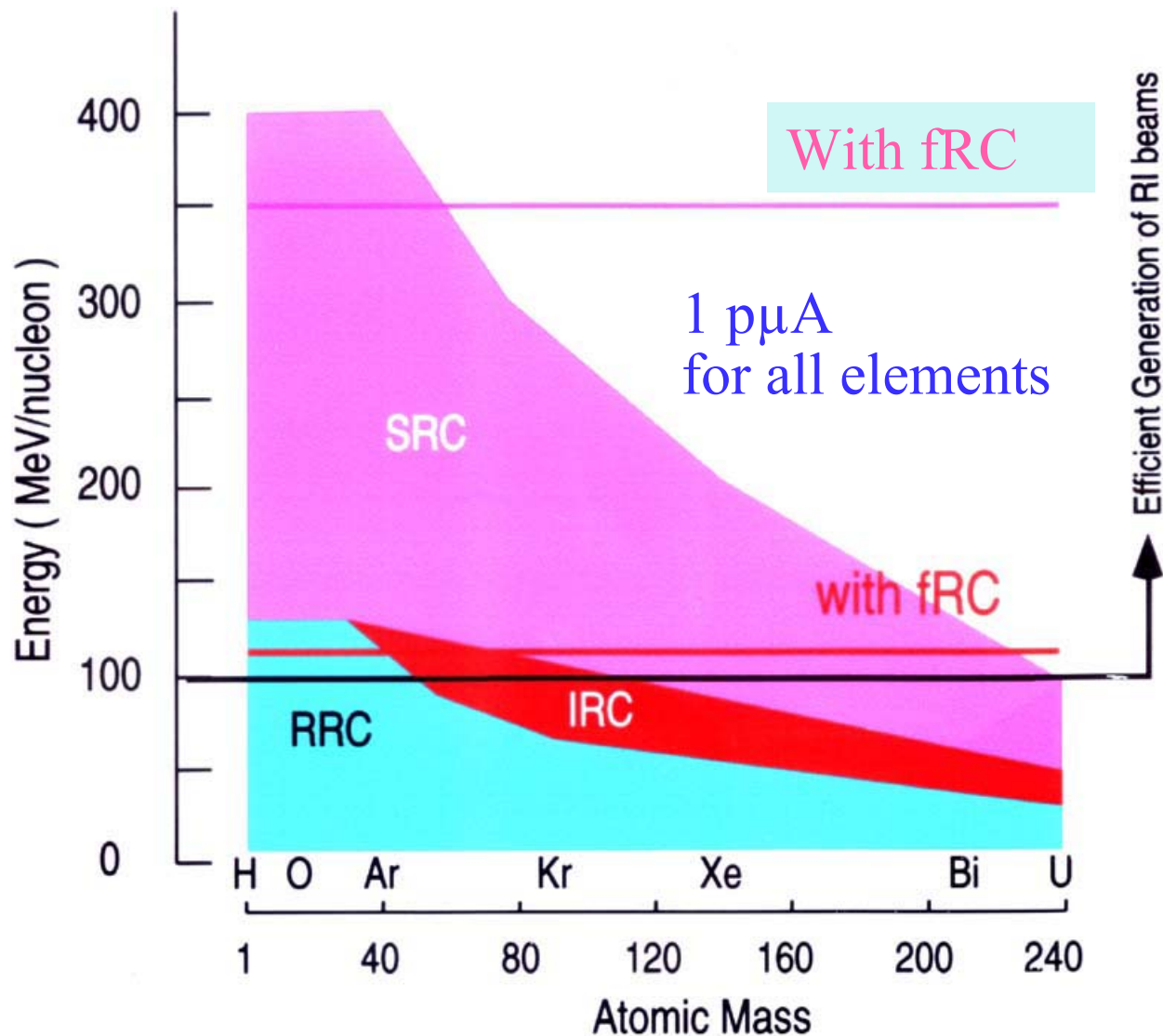


U 350/nucleon

Accelerators



Primary Beam Energy @RIBF



RIBF Site from Air

LINAC

RRC

Experiment
Building

Accelerator
Building

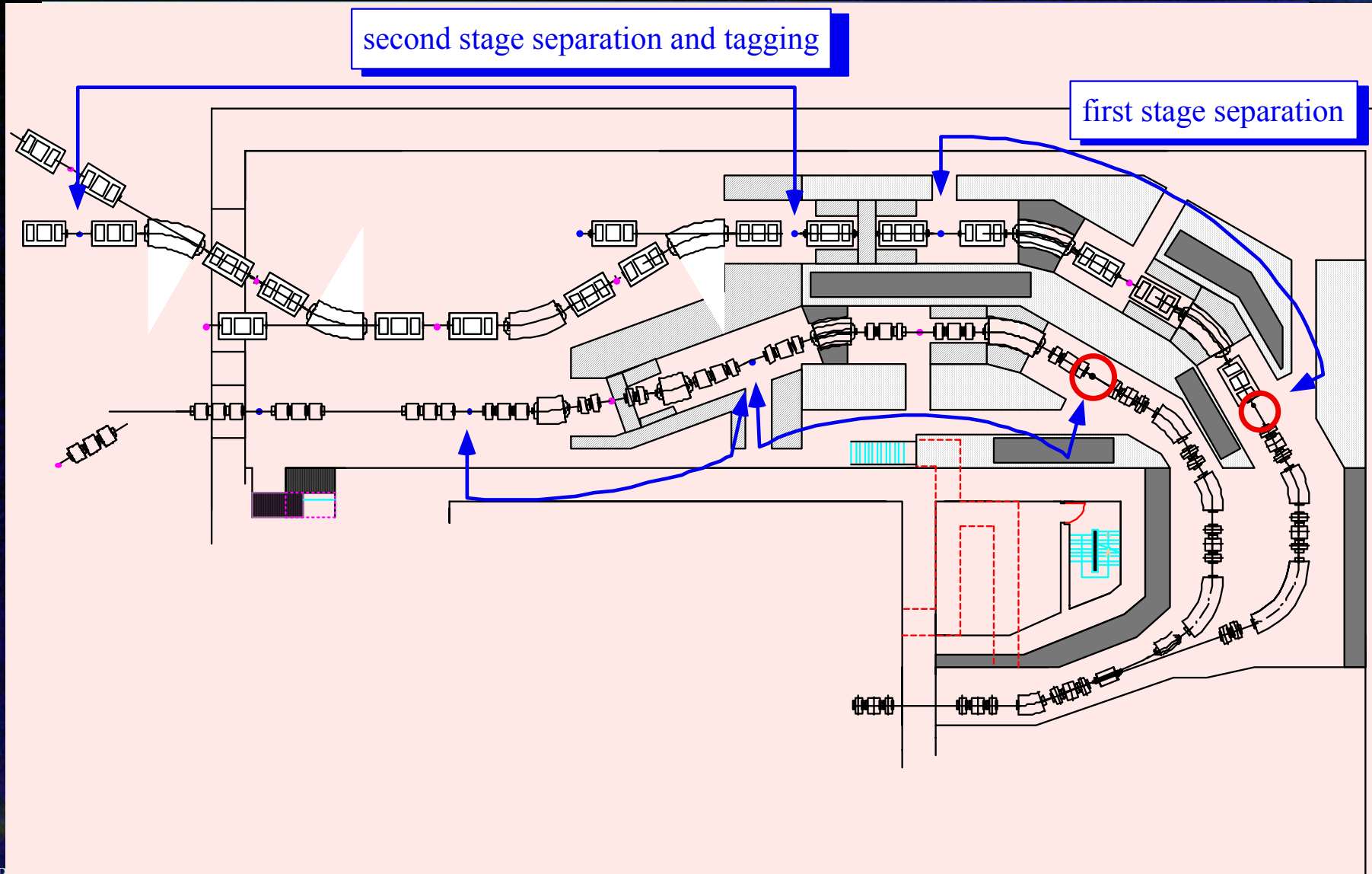
Accelerator Building Completed



Setting an RRC Sector



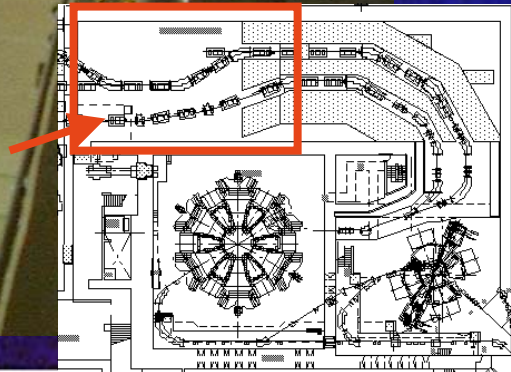
RI Beam Separators (Big-RIPS)



Building Construction for Big-RIPS

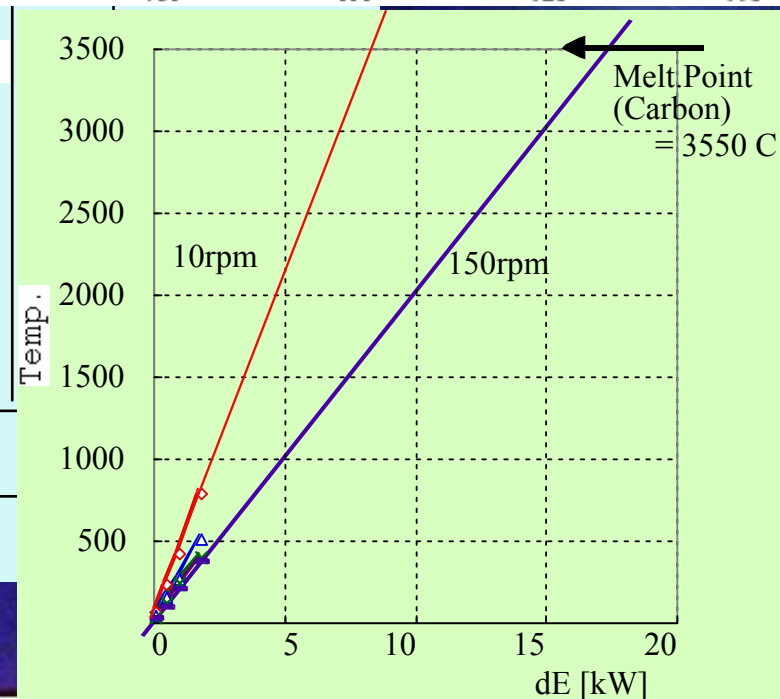
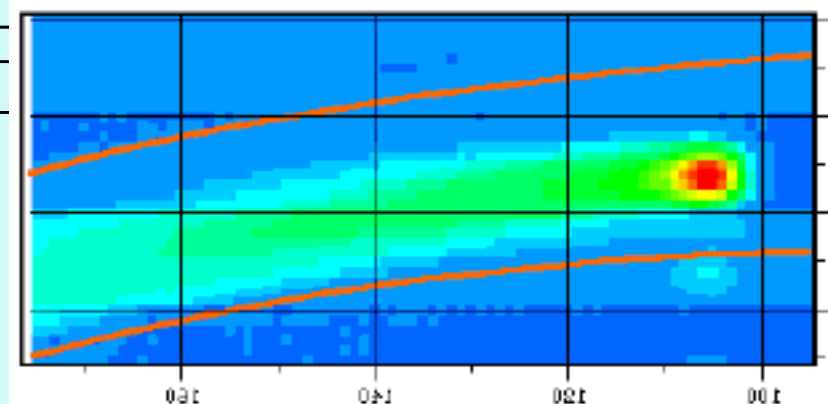
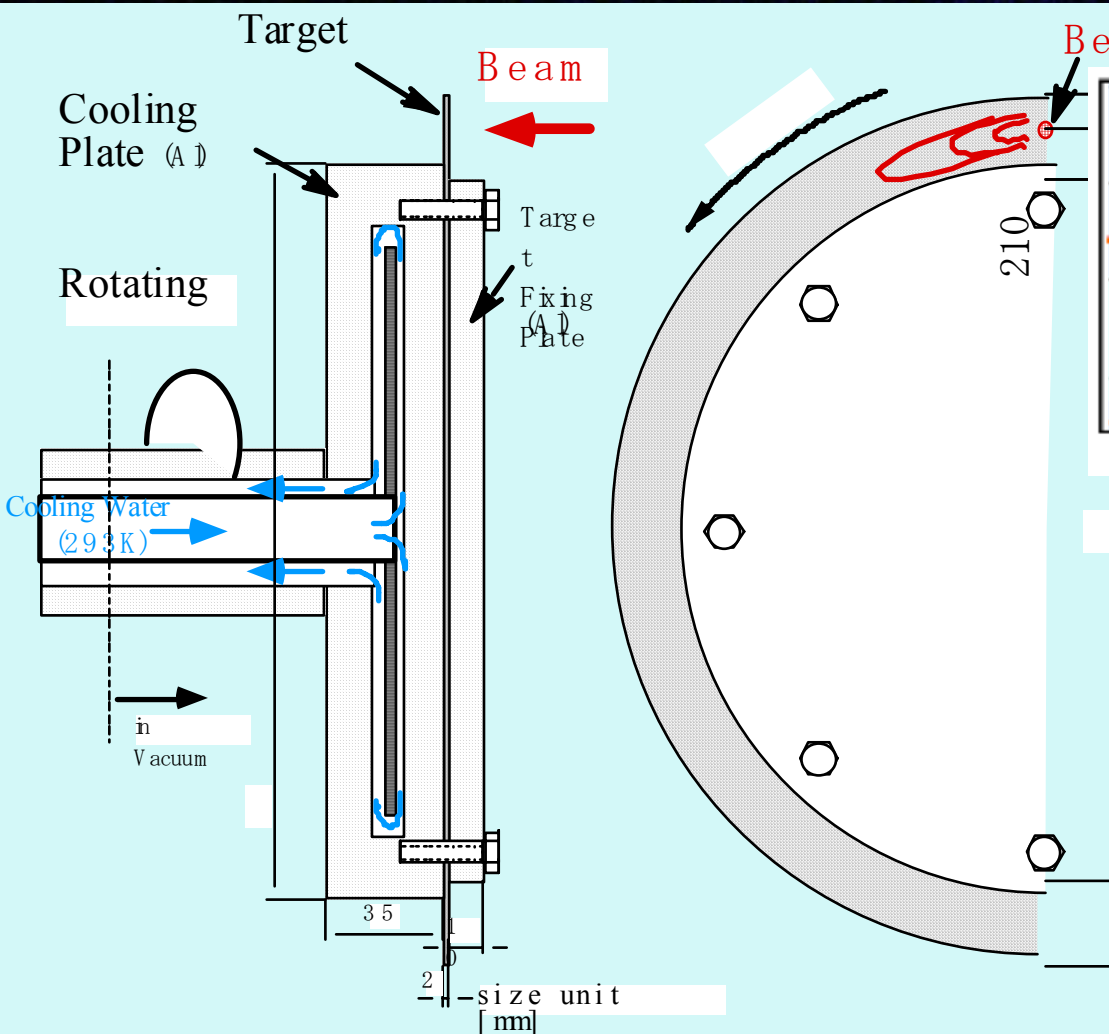


Big-RIPS Room Completed

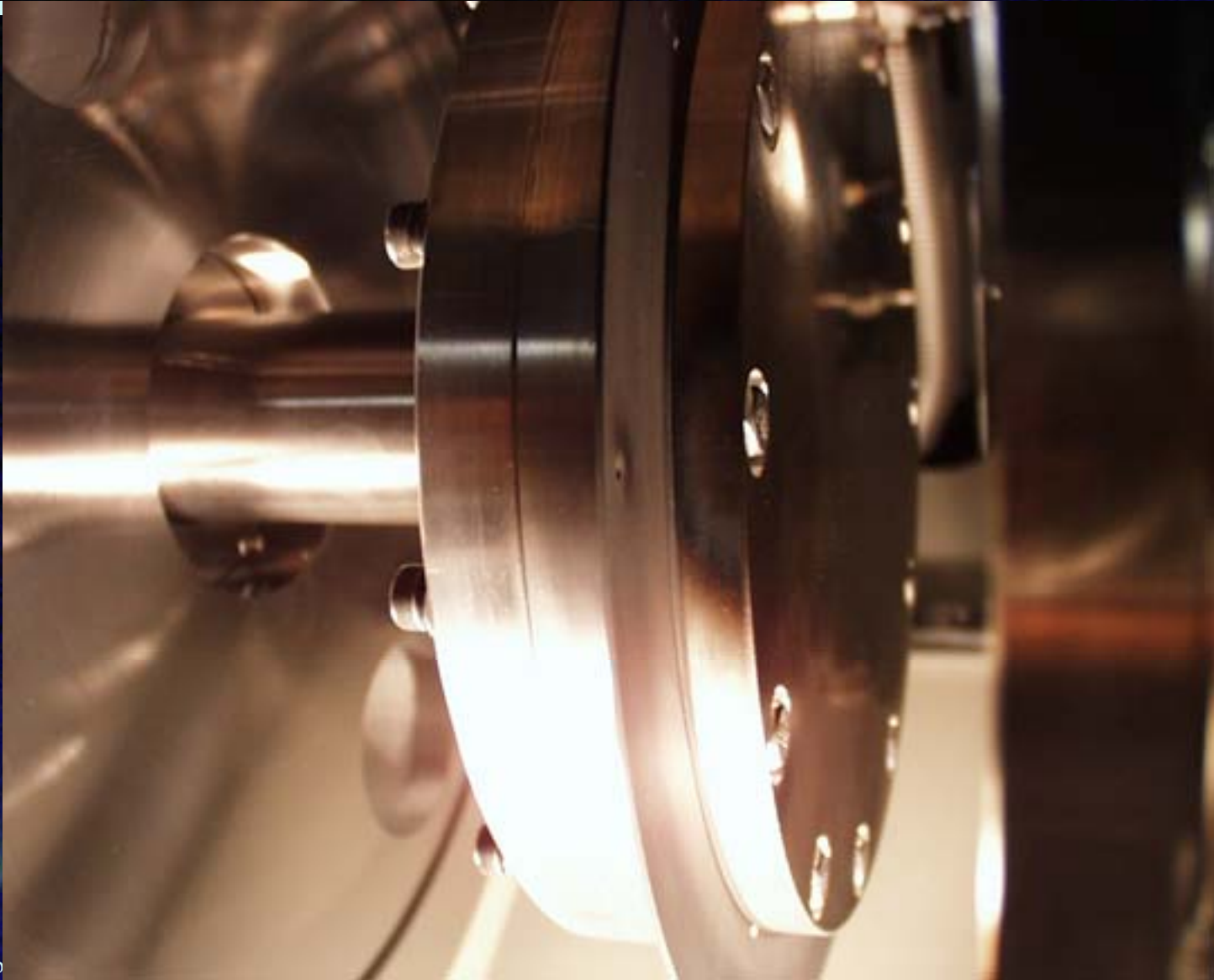


Production Target at RIBF

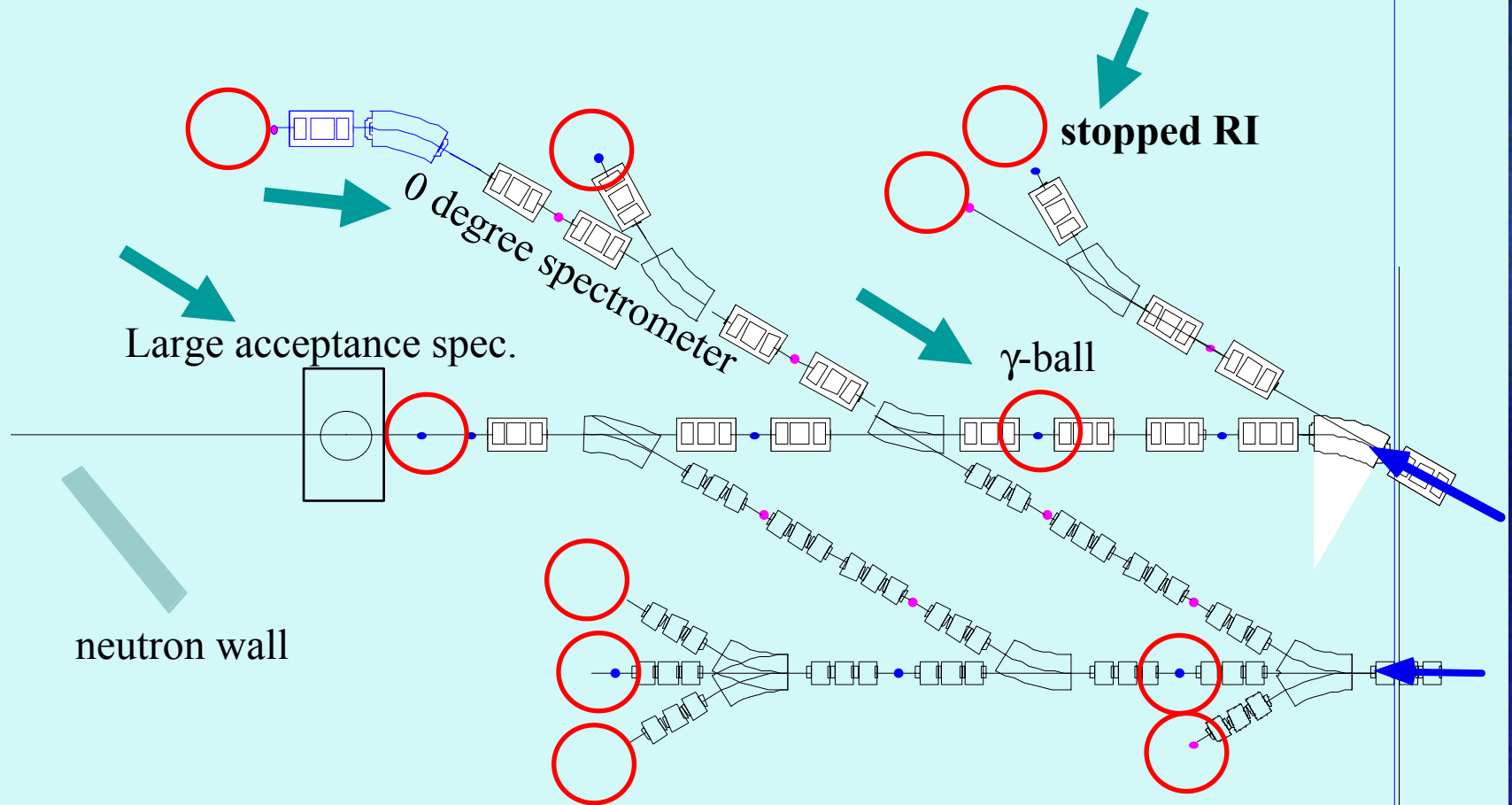
A. Yoshida



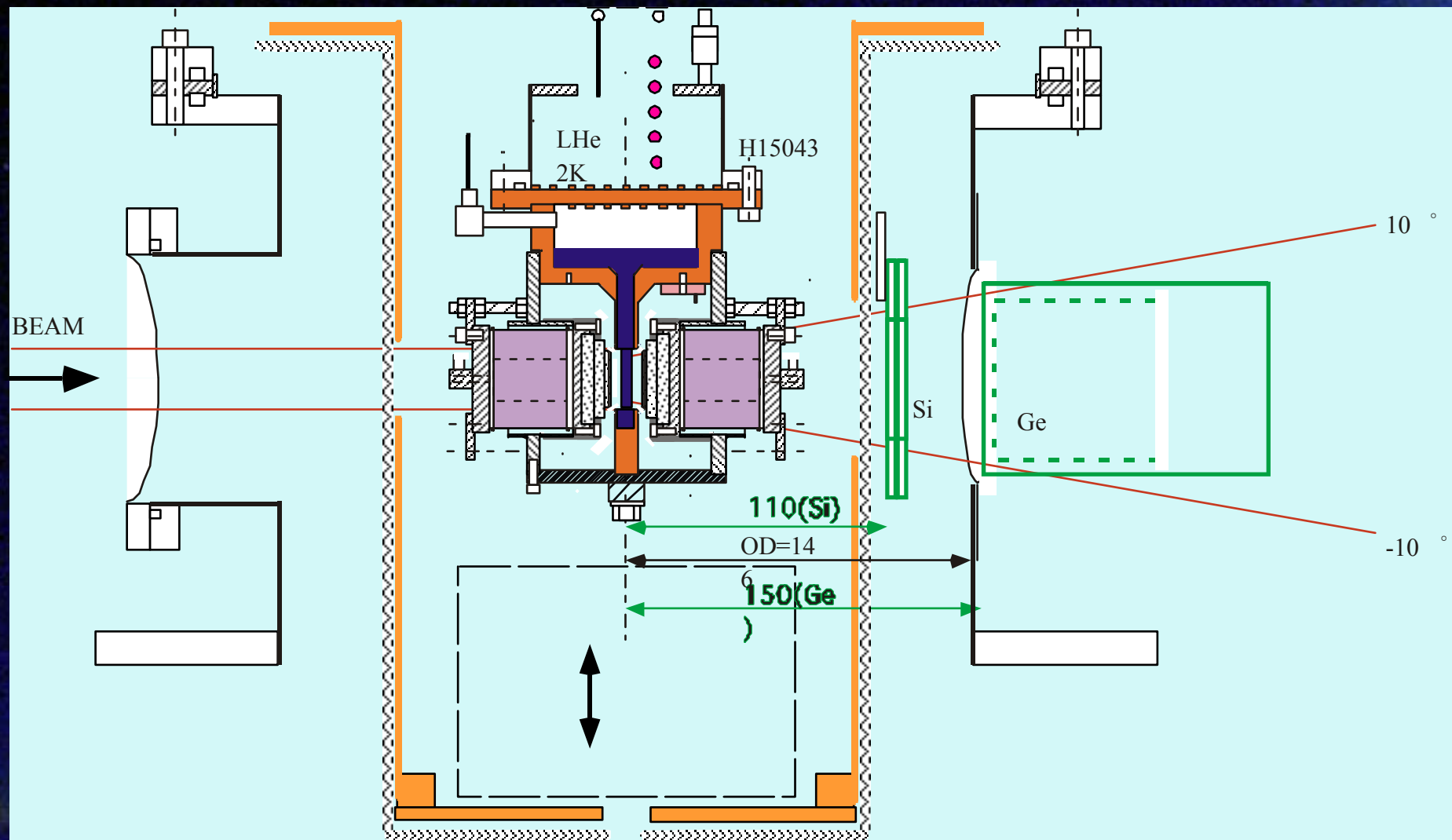
Rotating Target =photo=



Experimental Room



Solid Hydrogen Target

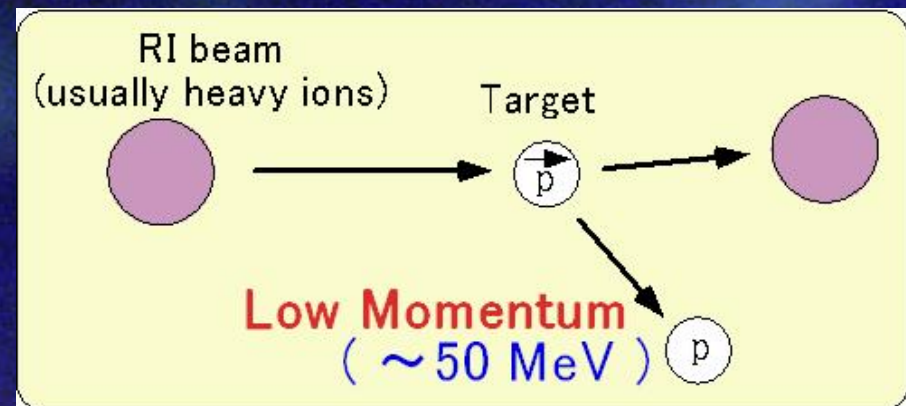


Solid hydrogen target

- ◆ No window!

Development of Polarized Proton Target

- ◆ Inverse kinematics requires a detection of low energy recoil.
- ◆ Special requirement for polarized target
 - *Low magnetic field is required.*
 - *Simple construction --> higher temperature*
- ◆ Polarized protons in aromatic molecule



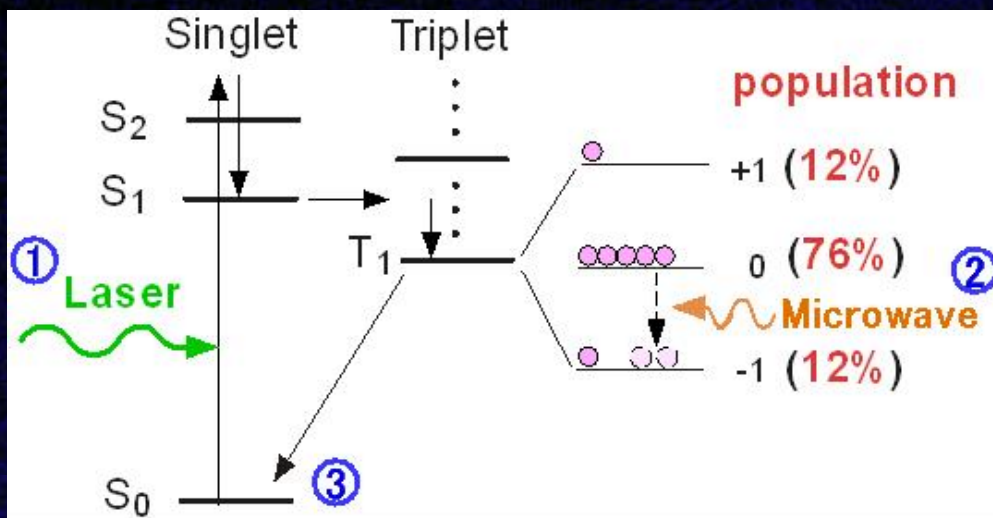
by T. Wakui and H. Sakai of CNS.

Polarizing Protons in Aromatic Molecules

Host : naphthalene ($C_{10}H_8$)



Guest : pentacene ($C_{22}H_{14}$)



① Optical pumping (Laser)

Electron alignment

② Cross polarization (Microwave)

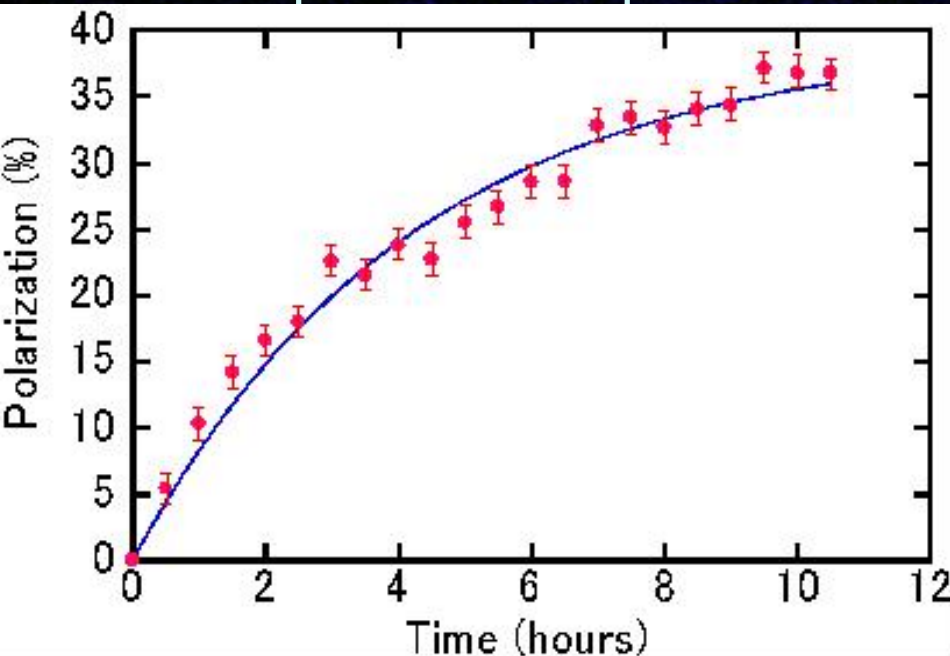
Electron alignment \rightarrow proton polarization

③ Diffusion of polarization

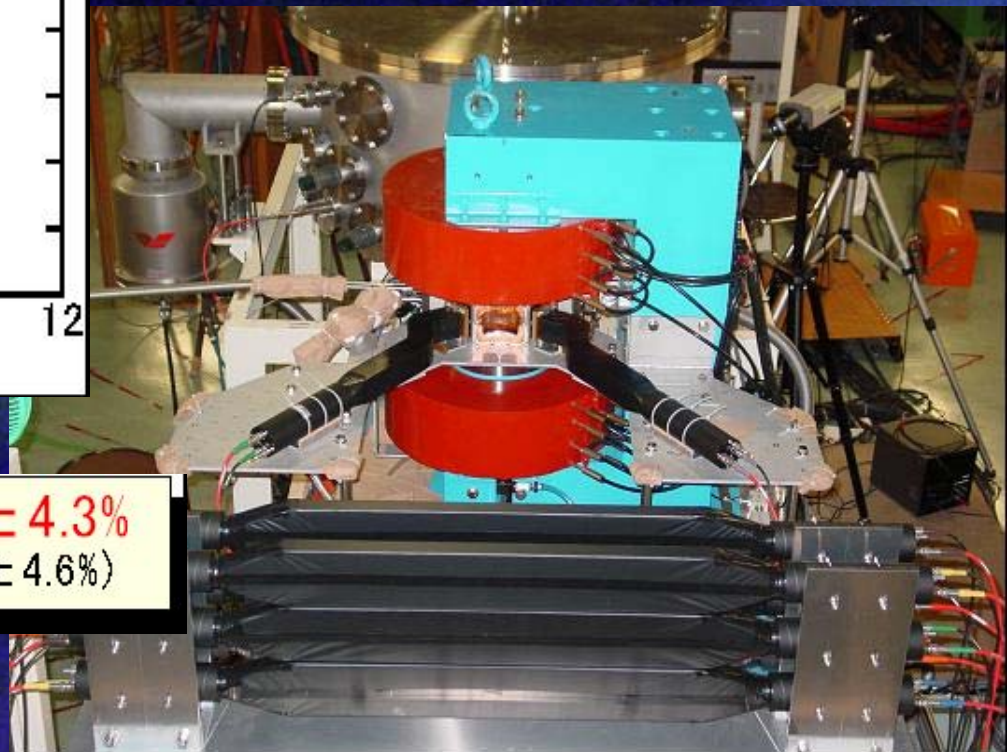
\vec{p} in Guest \rightarrow \vec{p} in Host

Proton Polarized at 100K under 3 kG

- Naphthalene doped with 0.01 mol% pentacene



Proton polarization : $36.8 \pm 4.3\%$
($39.3 \pm 4.6\%$)

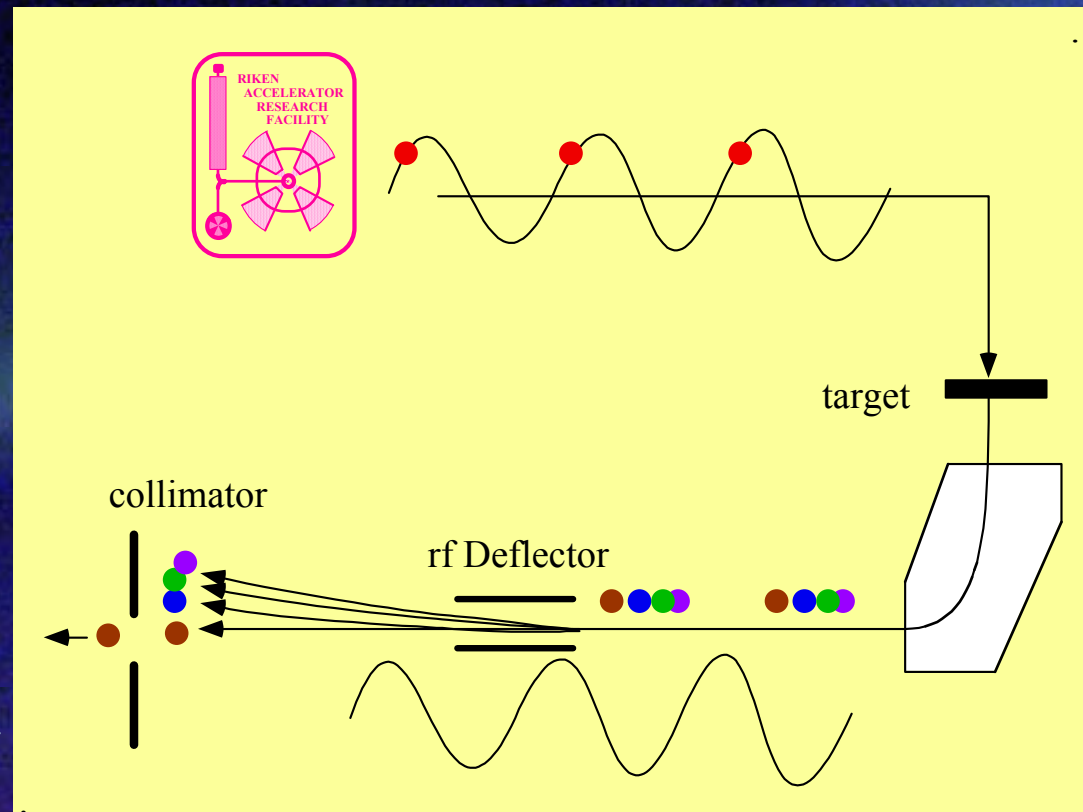


Additional Separation Method of RIB

- ◆ So far separation is based on the magnetic rigidity and the energy loss (Energy-loss-achromat)
- ◆ The velocity broadening of ions makes separation incomplete
- ◆ In particular, a proton rich RIB suffers a lot of admixture.

**rf deflector for
additional separation**

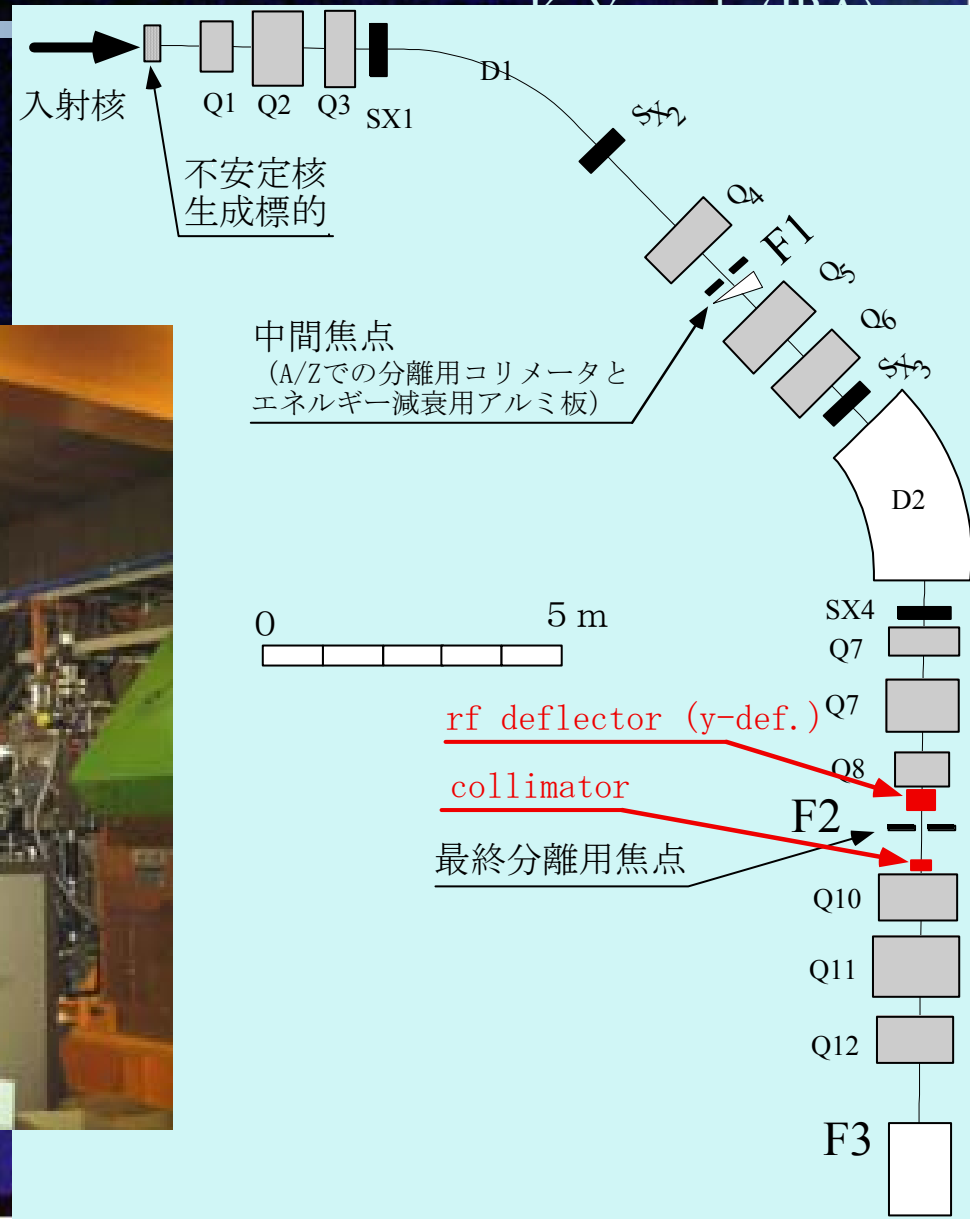
By Yamada



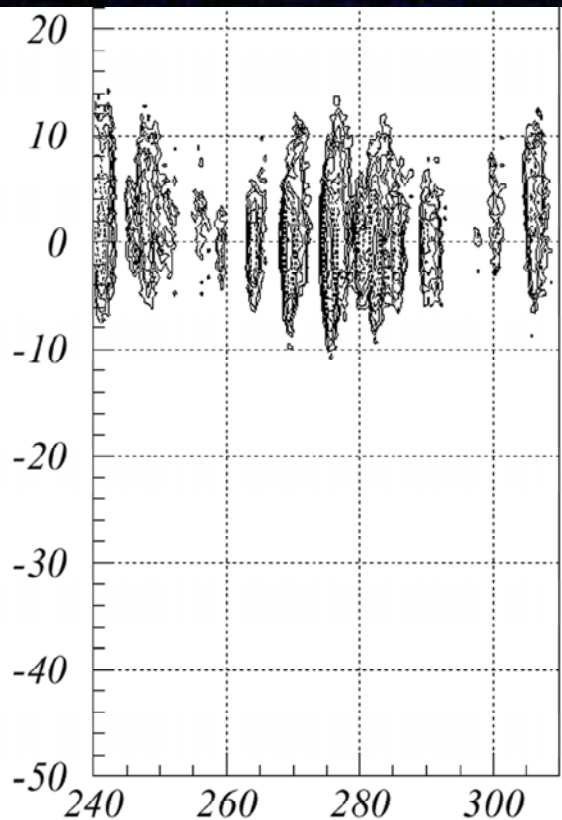
New rf Deflector for Additional Separation Power



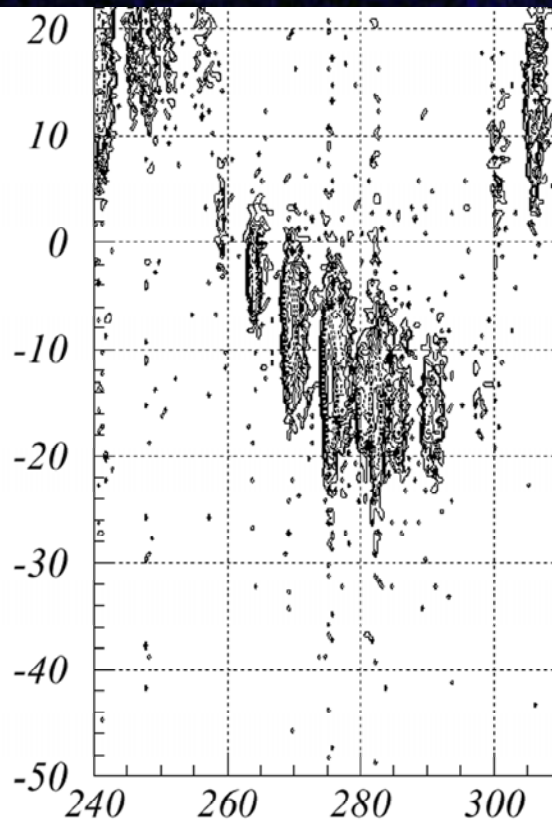
RIA workshop 8/26/03 @ Washington DC



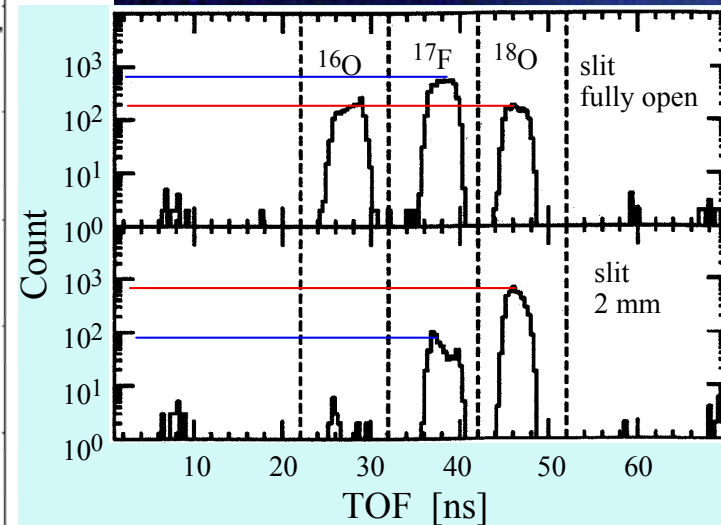
Separation Power of rf Deflector



ID=100, N=340686
 ^{46}Cr TOF vs Y deflector off



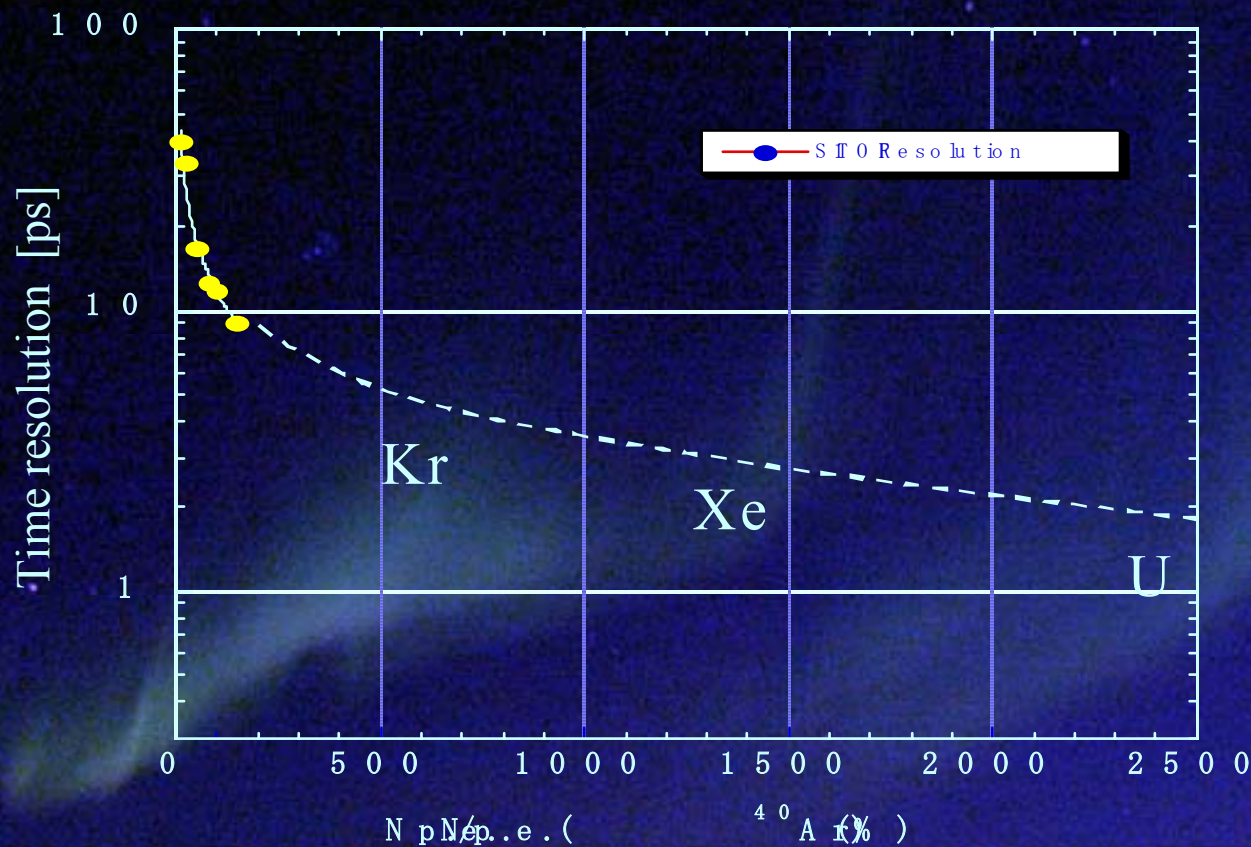
ID=101, N=94964
 ^{46}Cr TOF vs Y deflector on



$^{18}\text{O}/(\text{all})$: 0.15 --> 0.89
 $^{18}\text{O}/(\text{other})$: 0.2 --> 9

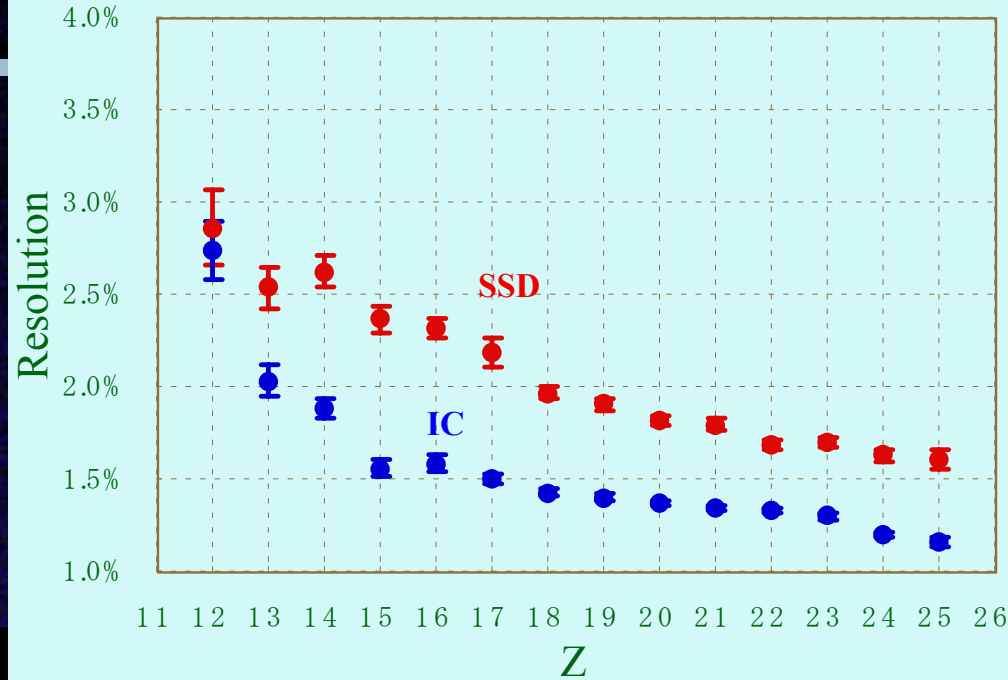
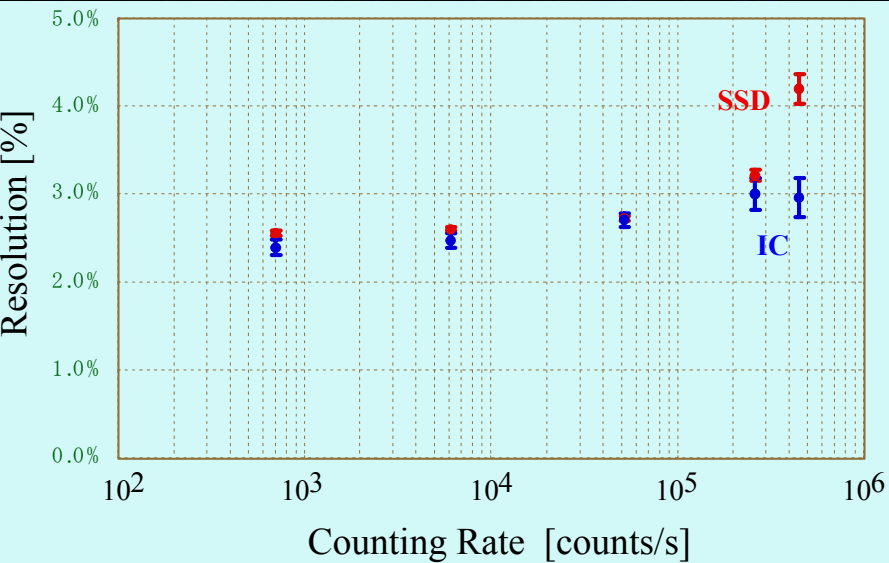
TOF resolution with new detectors

By R. Kanungo and
S. Nishimura

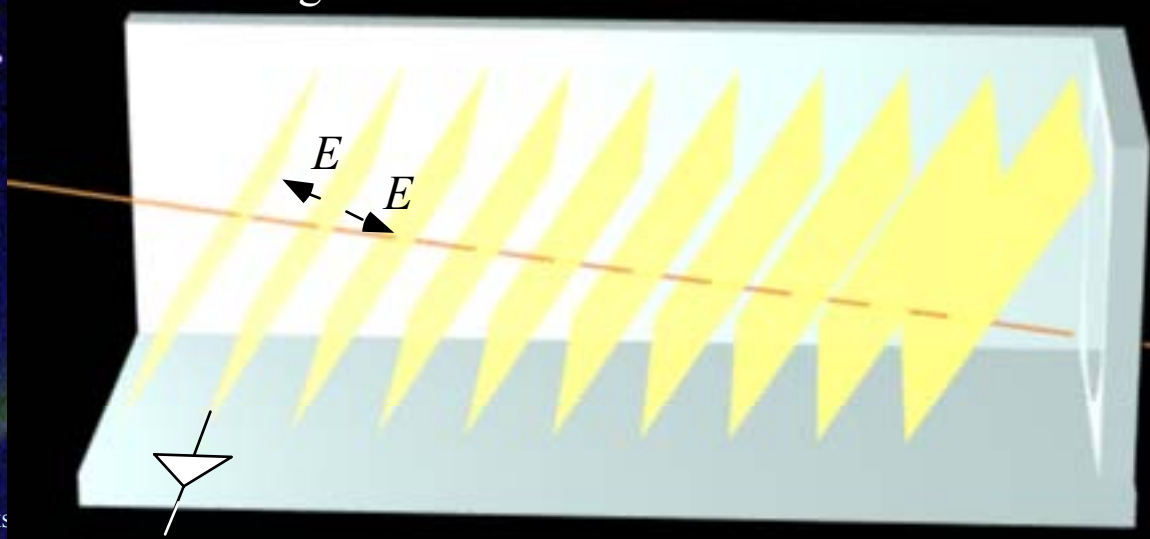


High Rate MUSIC

By A. Ozawa and
K. Kimura (Nagasaki)

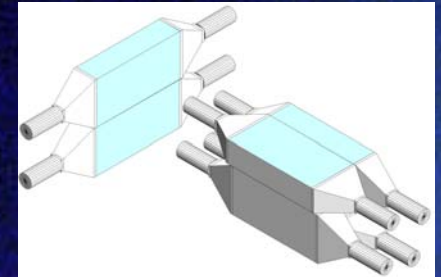
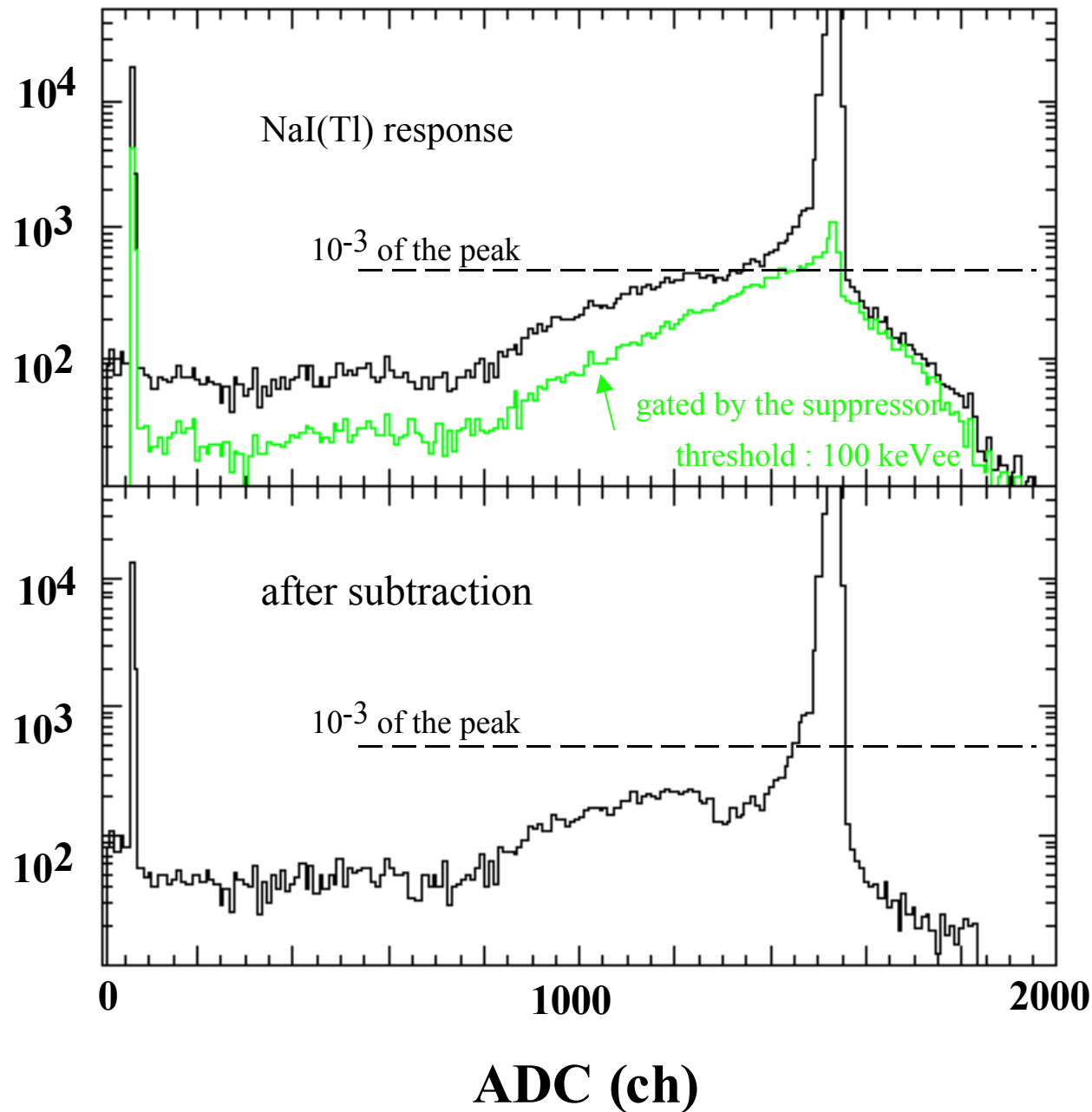


High rate MUSIC

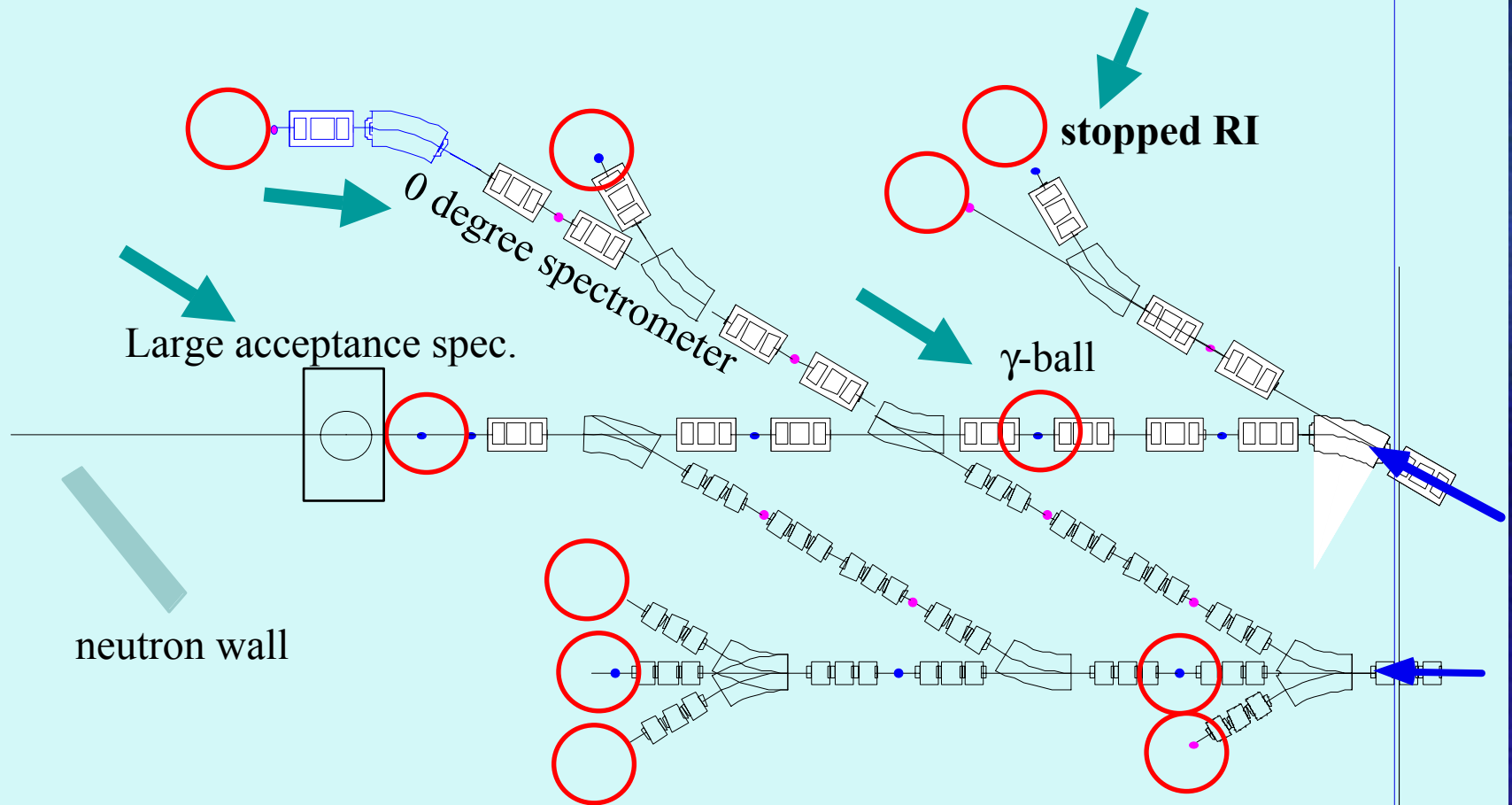


Reaction suppressed NaI(Tl) E-detector

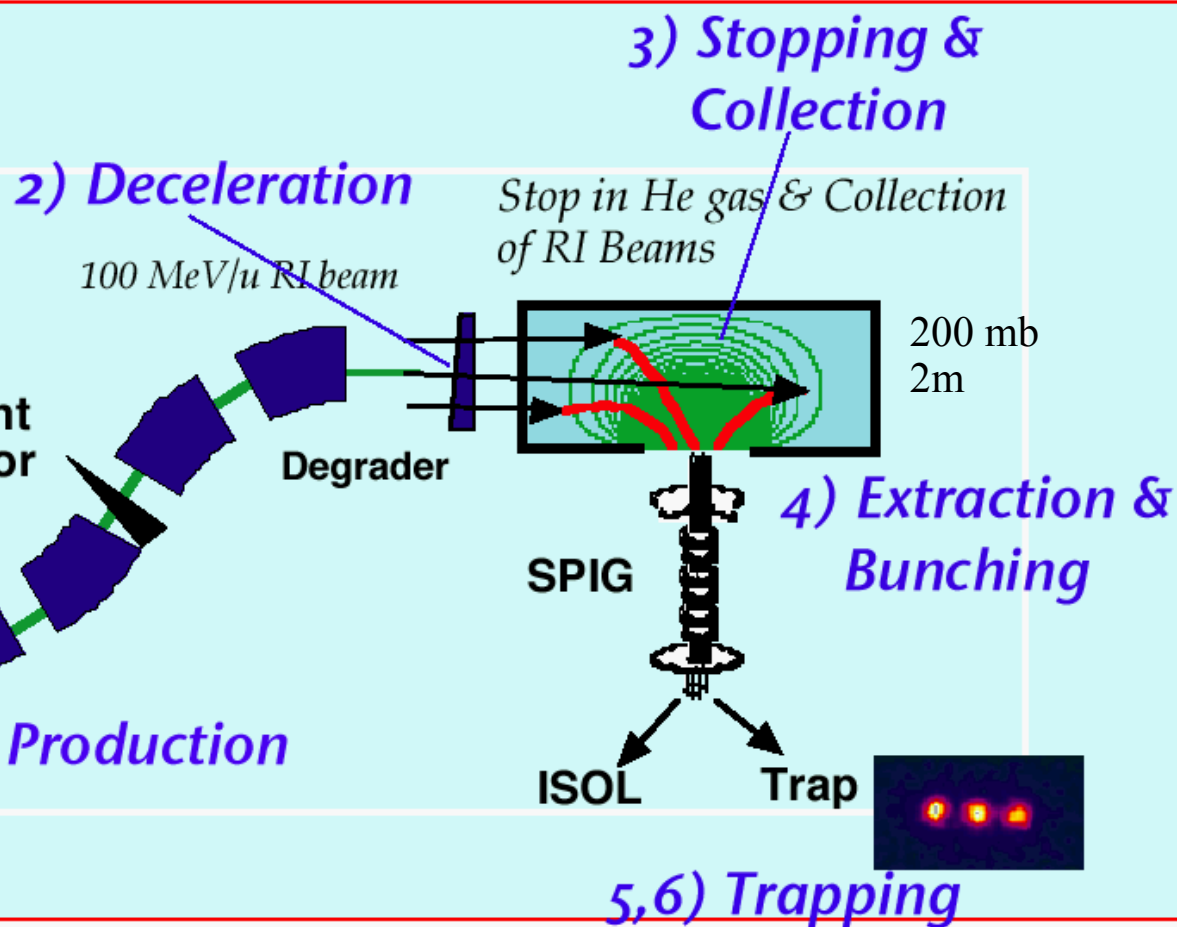
T. Suda



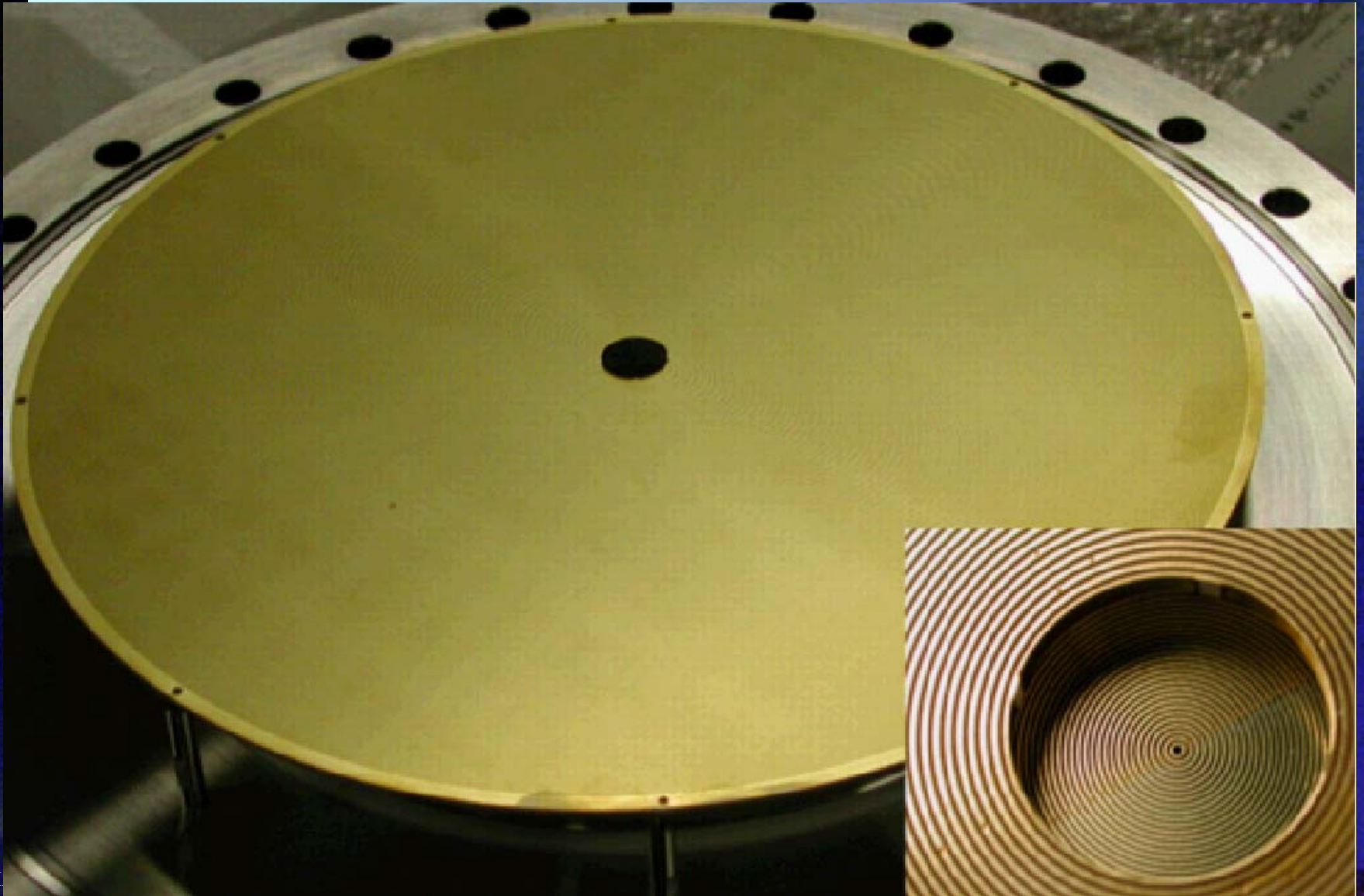
Experimental Room



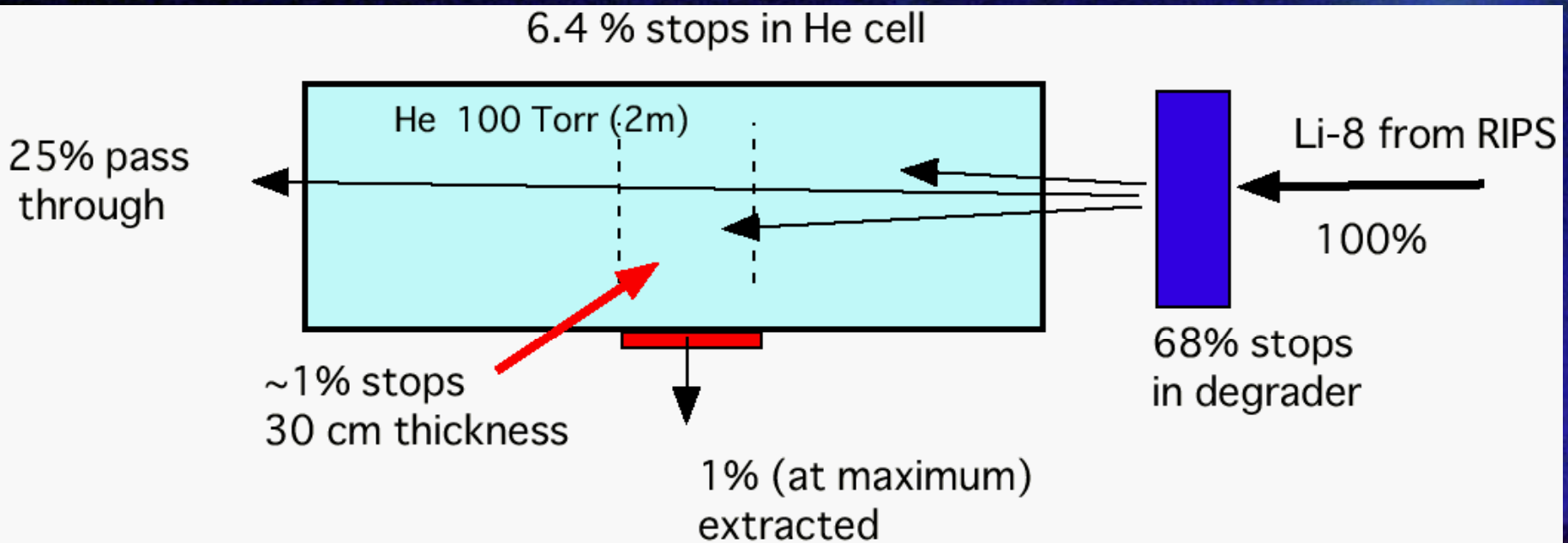
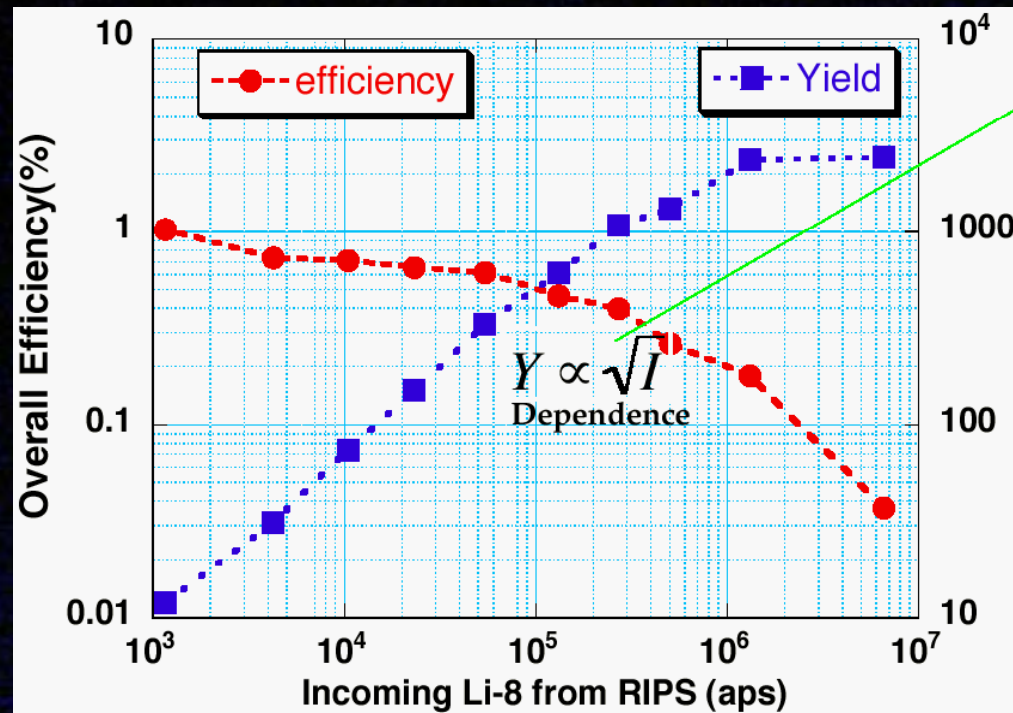
Gas Stopping R&D



RF Carpet Electrode

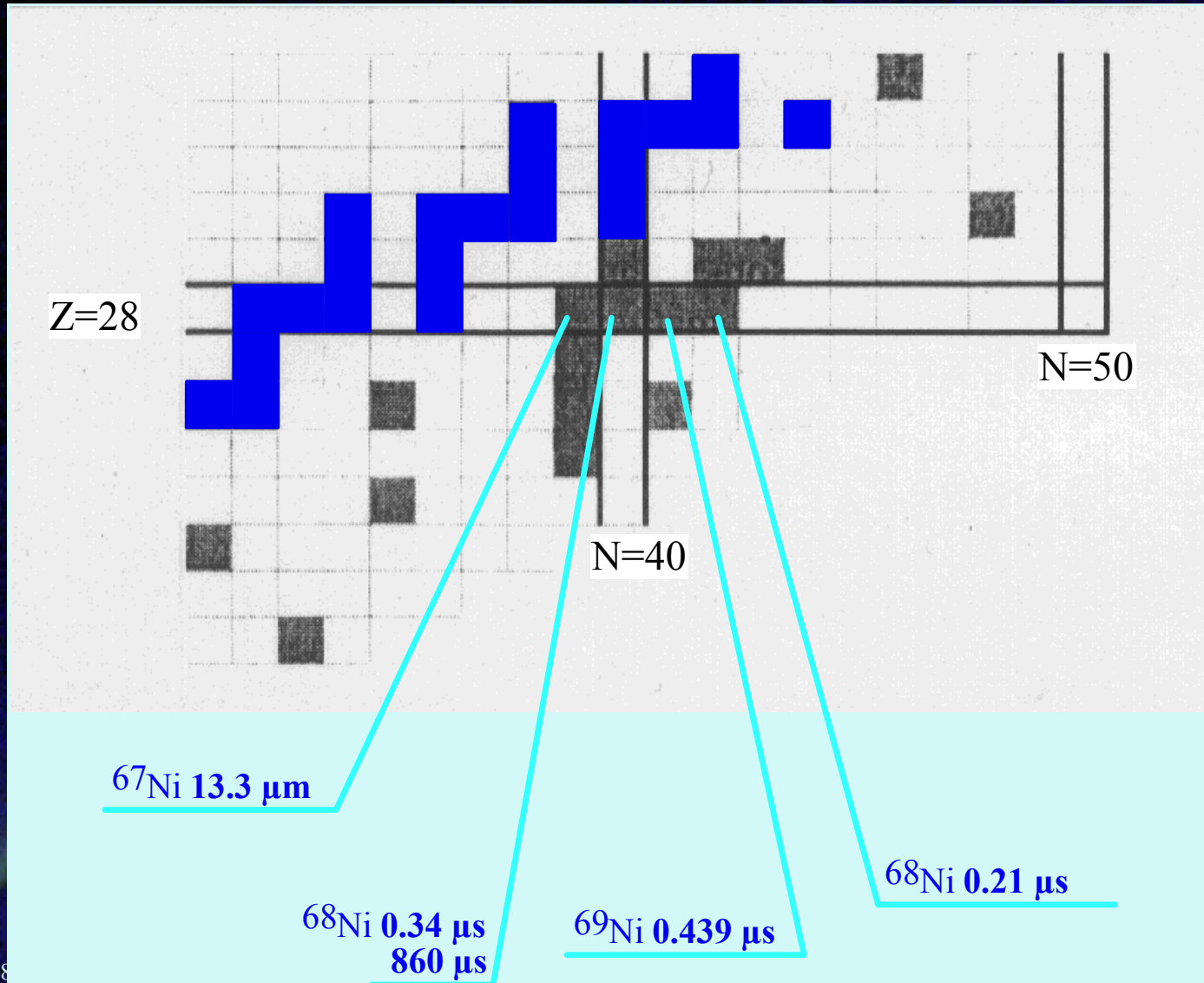


Efficiency of rf trap



Problem!!

Isomer Problem for All Measurements



Advantage of Storage Ring for Reaction Studies

- ♦ Isomer can be removed.
- ♦ High resolution for low-energy recoil.
- ♦ Possible to obtain high luminosity
- ♦ All stored nuclei may have nuclear collisions.

Special Requirements

- ♦ Fast cooling down to ms
 - *Cooling within nuclear lifetime ~ 0.1 s (ultimate ~ 1 ms)*
 - *But cooling is enough if RI ions are kept in the ring until nuclear collisions (Does not require best $\Delta p/p$)*
- ♦ How thick target one can use?
 - *Want all stored nuclei collide before.*
- ♦ Can we detect the injection of single ion quickly?
 - *Gives faster measurement cycle.*

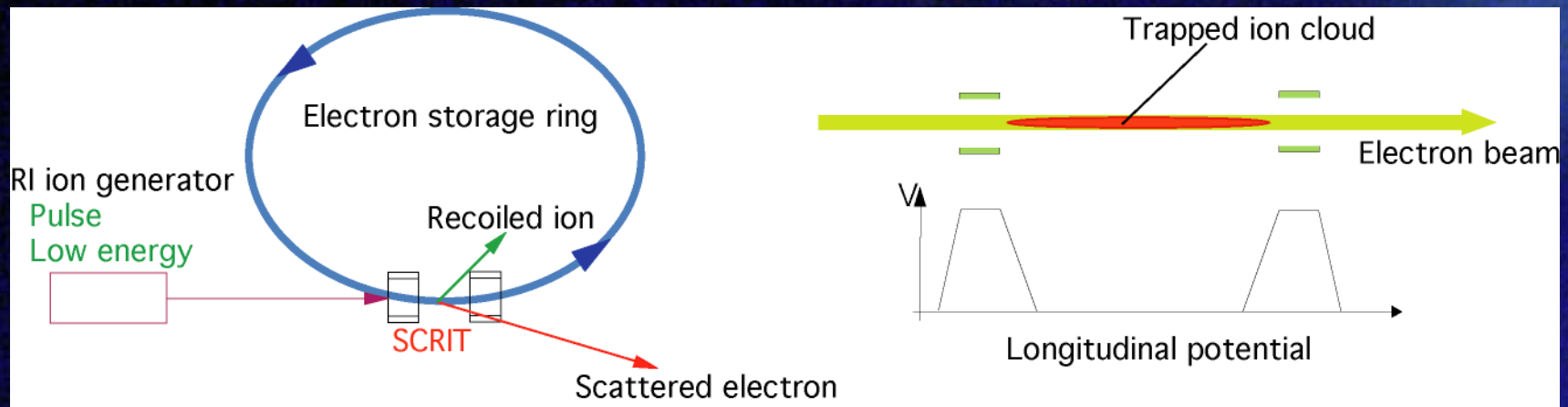
Back of the Envelope Consideration for internal target experiment

- ◆ Is 10^{18-19} atoms/cm² target usable? (0.1-1 μ m foil)
 - *We need high luminosity for nuclei far from the stability line with short life time.*
 - *1 nucleus in the ring makes $L=10^{24-25}$ cm²*
 - ◆ one reaction per second per particle (24)
 - *Reaction life time of the beam is 1~10 s.*
- ◆ Energy loss per turn = $0.2Z^2$ keV (for 1 μ m)
 - *acceleration voltage = 0.2 Z kV*
- ◆ Emittance growth can be well compensated by the acceleration.
- ◆ No energy cooling may be necessary.
 - $$\frac{d(\Delta E)}{dE} = -0.7$$

Electron scattering off unstable nuclei based on ion-trapping phenomenon observed in electron-storage rings

RIKEN, Rikkyo Univ.

SCRIT (Self-Confining RI Target)



expected luminosity (ex. Sn-isotopes)

$$L \geq 10^{27} \text{ (/cm}^2\text{/s)}$$

$$I_e = 500 \text{ mA}$$

$$N_{\text{inj}} = 10^8 \text{ /sec}$$

Feasibility study of the SCRIT method at existing electron storage ring, KSR, Kyoto Univ.

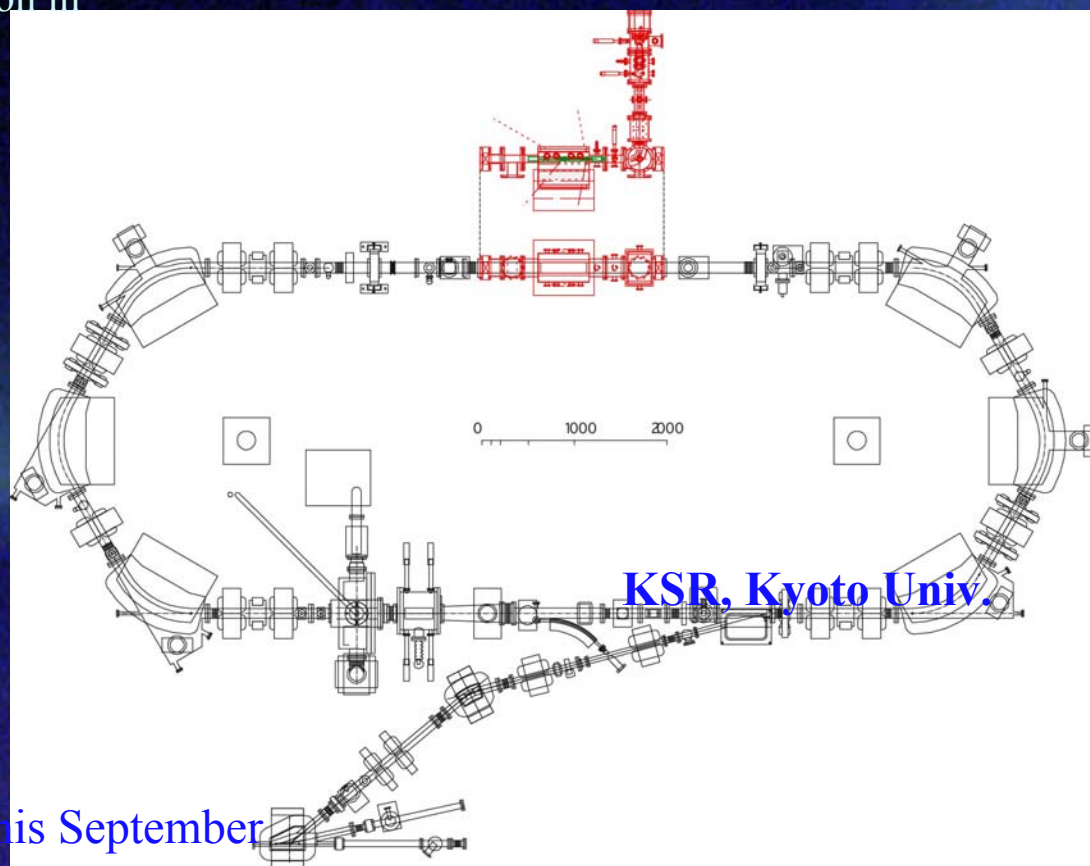
R&D Sn(e,e')

1. Injection & trapping of Sn isotope injected from an external source
2. Detecting elastically scattered electron in coincidence with recoiled Sn
3. Luminosity monitoring

SCRIT test chamber

Exp. Condition

1. $E_e = 100\text{-}300\text{ MeV}$
2. $q = 50 - 150\text{ MeV}/c$
3. Electron beam current $\sim 100\text{ mA}$
4. Beam size $\sim 1 \times 1\text{ mm}^2$



R&D starts from the middle of this September

RIBF...

- ◆ RIBF will be ready for experiment by the end of FY2006.
- ◆ Experiments are planned in 2007.
- ◆ Experiments under discussion for the first periods
 - *Expansion of nuclear chart*
 - *Lifetime measurements of R-process path nuclei*
 - *Interaction- and fragmentation- cross sections of heavy nuclei*
 - *Proton elastic scattering of exotic nuclei*
 - *Coulomb excitation of exotic nuclei*
 - *Gamma decay of excited state of exotic nuclei*

Thank you for your attention